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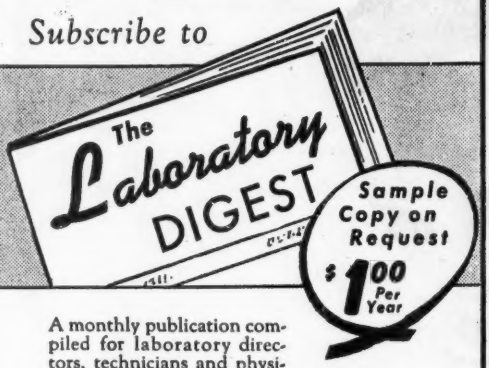

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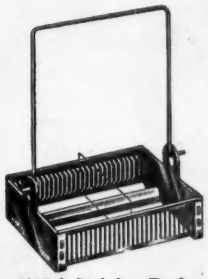

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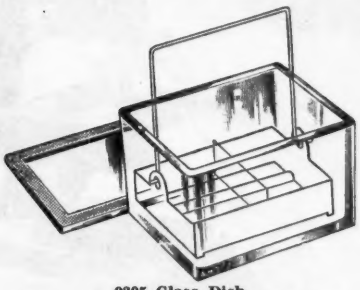

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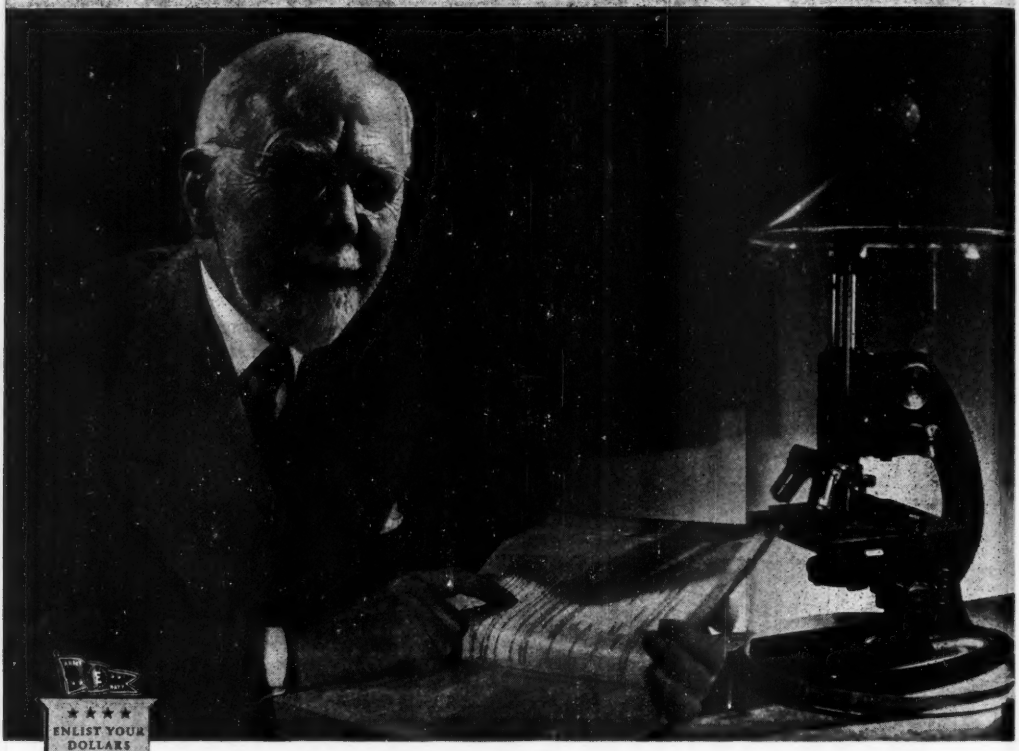

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EDGELESS STARS

By Dr. SERGEI GAPOSCHKIN

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(1) *Introduction.* In the last three or four months there have appeared some new results in the study of the eclipsing variable stars, which seem to be gaining more and more importance. In order for the reader to understand this I should like to describe first the importance of the eclipsing variables for the study of stars in general and then proceed to the edgeless stars.

(2) *The Fundamental Parameters.* There are a few characteristics of a star which are fundamentally important, or at least considered fundamentally important; they are mass, radius and effective temperature. The eclipsing variables provide us with these characteristics. Through the eclipsing variables we think often about the stars in general. That is why the research on eclipsing variables has never ceased to be interesting, and valuable contributions are in progress in many countries all the time. It is with regret that the author can not discuss this general research on eclipsing variables. But space is limited and the new results given here seem to have little connection with the general problems.

Since the time when the first spectroscopic binaries were found, it has been realized that the application of the law of gravity to the observed motions of the components in a binary would lead to the determination of their masses. Since, however, the tilt of the orbit of the spectroscopic binaries is undetermined, the spectroscopic observations alone give only the so-called minimum masses. If it happened that a spectroscopic binary is at the same time a photometric binary, we can do some additional computations. In such a case we see how one component covers the other, producing an eclipse. From the amount of the drop in brightness of the star we can estimate the tilt of the orbit. In other words, we can remove the indeterminacy inherent in the purely spectroscopic observations of a binary. That is why the eclipsing variables are very important. Through them we determine the

masses of the stars. Indeed out of about 120 well-determined masses known to-day, the eclipsing variables have provided more than 80. The rest are found from the observations of visual binaries. If one remembers that the visual binaries embrace a less varied group of stars than the eclipsing variables, the usefulness of the latter is evident.

In addition to supplying us with masses, the eclipsing variables give us the means of finding the radii of the stars. Indeed they have no rival in this field. The sun is the only star whose radius we see directly and can measure. There are a few (about a dozen) large red stars which were measured with the interferometer, and their angular radii are accordingly known. But for an idea as to dimensions for the vast majority of stars we are indebted to research on the eclipsing variables. The duration of the eclipse gives us a clue about the sum of radii in terms of the distance between the centers. For example, if the components were in contact one would have a "permanent" eclipse, and if the components were far separated the duration of the eclipse would be very small in respect to the period of revolution. Each case is naturally different in details, but altogether we now have several hundreds of radii of stars determined in this fashion.

The effective temperature of stars has its determination in the study of radiation. But, in practice, astronomers here again are indebted to the study of the eclipsing variables. For if we define the effective temperature by saying that it is a temperature (T) which makes a star so bright (L) and with such a radius (R) that

$$L \sim R^2T^4,$$

then, having found the radius in the manner described above and the intrinsic brightness from the trigonometric parallax and the apparent brightness, we have a definite value of T. From these considerations it follows that the radius is more fundamental than the effective temperature, in practical determination of their values. For the effective temperature, as far as the research on eclipsing variables is concerned, is determined after the radius has been found. It must be mentioned that the determination of radii is to a small extent dependent on the mass of the system. But the error in the determination of the mass is not great, therefore the radius depends chiefly on the type of the eclipse.

From the steepness of the eclipse we can deduce the ratio of radii of the components. For if the components are equal in size the drop in brightness during the eclipse will not be the same as when the components are different. In the former case we should never have constant brightness at the bottom of the minimum, even if the plane of the orbit were exactly in the line of sight. If the stars differ in size the eclipse may have a flat bottom. This consideration is based on the assumption that the discs of the stars are uniform in distribution of brightness. From the exposition below it will follow that one can have a flat bottom even in the case of equal radii but with non-uniform brightness over the disc.

The present methods for evaluating the essential elements from eclipsing variables are naturally not new. They have been realized many years ago, in the beginning of this century, in the works of Meyer, Dugan, Ceraski, Blazko and especially in the later work of Russell and Shapley. The technique of computations has been modified and extended notably in Holland by Fetlaar, in Russia by Krat, Nekrasova, Martinoff and Odinzov and in the United States by Wyse and especially by Kopal. The observational and computational material has been greatly accelerated in the works of Martha Shapley, Zessewitch, Henrietta Swope and through the computing bureau financed by a grant from the Milton bureau of Harvard University. Some of the recent results are incorporated in this paper.

The fact that we are close to the sun has much to do with many of our conceptions, and one of them is the conception of the sharp disc: that is, that the radius has a quite definite value, which is the better known the more precise the instrument used in determining it.

In the computation of the radii of the eclipsing variables this conception of one definite radius for the star has always been axiomatic. To be sure, we have made modified computations for the radius of eclipsing variables to take into account the so-called limb-darkening, the fact that the brightness on the disc of the star may not be uniform from center to the edge. In cases where one solution (uniform or non-uniform brightness) was more representative of the photometric observations than the other, we have adopted it as giving the definite value of the radius of the star. Sometimes neither the uniform nor the "darkened" solution gave a perfect representation of the observations and the deviations were not such as could be ascribed to ordinary observational errors, whether we observed in the visual or photographic light. The radius was generally accepted as uniquely determined. In confirmation of this procedure we note that the formulae given in all text-books for the derivation of the color index of a star are based on the assumption of one radius for all wave-lengths. My results seem to lead to an opposite conclusion.

(3) *Light Curves in Several Colors.* If one compares the duration of the eclipse for the same system in photographic light and in visual, one finds for some eclipsing systems that the photographic duration is shorter than the visual; it takes less time. Since the inclination of the orbit must be the same for both sets

of observations it follows that the radii (or at least one of them) are smaller, when measured in photographic light than in visual light. This might be called a "shrinking" effect for a star; in going from the visual towards the photographic wave-length the calculated size decreases. Generally, it may be called the "edgeless" effect.

In addition, the steepness of the drop of brightness is greater in photographic light than in visual. It seems thus as if the ratio of radii expressed in the usual terms of the eclipsed to the eclipsing component is smaller in the former than in the latter case. The consequence would be that one of the components "shrinks" more than the other, or, in other words, the one component is more "edgeless" than the other. This is probably correct for the systems with widely different components. If, however, the components are nearly equal in size and in spectral characteristics the ratio of radii will probably be the same in visual and photographic light.

A third part of the same edgeless effect is that the elliptical shape of the close components differs with wave-length. When they are close to each other the usually spherical shapes are distorted into ellipsoidal shapes with the major axes pointed toward each other. Then the light of such a system will no longer be constant outside the eclipses and it is obvious that from the amount of variation of the brightness outside the eclipse we can obtain an idea about the degree of ellipticity of the components. We usually assume that both components have the same ellipticity and are strictly in alignment. The deviations from these assumptions have been discussed only in recent times (Kopal, Krat and Odinzev) and are difficult to follow observationally (Martinoff). The edgeless effect expresses itself in the fact that the ellipticity in photographic light is observed to be smaller than in the visual. Summarizing, the effect consists of three parts: The radii are smaller; the ellipticity is smaller; the ratio of radii is smaller. These results were first found on the two systems RX and SX Cassiopeiae about four months ago. The number of the known eclipsing systems with the shrinking or edgeless effect is increasing rapidly. In the table below I summarize the observational material.

I should like to accentuate one detail of this result. The discovery (or whatever it may be called) of the effect was made possible by comparison of the results obtained from visual observations with those from photographic ones. But such intercomparison of the light curves of eclipsing variables is at least twenty-five years old. And since the difference in the duration of eclipses obtained from two light curves is rather large it is possible that this difference, or this edgeless effect, has been noticed by many workers on the eclipsing variables. But if it was, the discrepancy apparently has been authoritatively disregarded and one set of observations was considered unreliable. Or attempts were made to bring the duration of the eclipses from both light curves into coincidence.

Table 1 contains nine systems, known to me, on which I have been working photographically and for which results from visual observations are published already. I have arranged the stars in respect to the length of the period, for it seems that the effect depends much on it.

TABLE 1

ECLIPSING SYSTEMS WITH "EDGELESS" EFFECT

Star	Period	Spectra	Change in radius Per cent.	Change in ellipticity Per cent.
SX Cassiopeiae	36d.6	A6, G6	140	13
RX Cassiopeiae	32.3	A5, G5	60	8
AR Monocerotis	21.2	?, K	44	5
RZ Scuti	15.2	B2, ?	13?	?
RY Persei	6.9	B6, F8	25	?
RS Can. Venat.	4.8	F4, G8	18	2
U Cephei	2.5	A0, G8	11	3
RZ Cassiopeiae	1.2	A2, ?	9	0?
ER Orionis	0.4	G1, G5?	3	4

The change in radius and in ellipticity is expressed in terms of the photographic values for the radius and for the ellipticity.

From the nine variables, seven light curves were compared after the two photometric systems had been reduced to the international scale.

The first spectra in Table 1 are those of the star which is eclipsed at the primary minimum; it is always of "earlier" type and the observed edgeless effect refers chiefly to it. In most systems the second minimum is too shallow to discuss the reversed effect on the later type component by the earlier. Since the ellipticity is always a combined effect and since the later component is in all our systems the larger one of the two, the change of the ellipticity as given in the table is probably chiefly due to the change of the component of the later spectral type. It should be pointed out that the uncertainty in the ellipticity is smaller than in the determination of radii, so that the changes in ellipticity as given in the table are of the same degree of reliability as they are for the changes in radii.

The system AR Monocerotis is very interesting because the observed spectrum is not that of the component which is most conspicuous in the photometric observations.

Considering the table for a moment, we see that the largest effect is for the first system: the radius of its blue component is in photographic light four tenths as large as in the visual. Probably this system is an extreme case in physical and observational conditions, but we may expect that eclipsing systems with much longer periods than of SX Cassiopeiae will show an

even larger difference. Looking down the table we see that there is a strong correlation between the period and the size of the effect. The small system ER Orionis, the components of which are similar to our sun (the radii are about 0.6 and the masses 0.5 that of the sun), does show the difference, but the smallest in the table. Both the sign of the difference and the photographic radii are smaller, and the degree of the difference for this system seems to be of interest in connection with our general approach to the problem of edgeless stars. The system was observed in both wave-lengths by Taylor and Alexander four years ago, whose data are given in this table. The spectrum has been determined by Struve quite recently.

Except for four systems, the rest of the table contains systems of which the chief component is of spectral class A. Probably that is why the correlation between the period and the edgeless effect is so strong. The tabulation begins with a supergiant and ends with the normal A component of RZ Cassiopeiae. Since the edgeless effect was pointed out only in recent months the number of recognized systems is, as yet, small in comparison with the two or three hundred eclipsing systems for which the visual and photographic light curves may be obtained; therefore no affirmative general statements should be made.

Some of the changes given in the table are within the limits of the errors of the observations; thus real values of the effect remain uncertain for such systems. There is, however, for all a definite indication of the edgelessness of the stars.

If we consider the physical structure of a star's atmosphere in a more general theoretical way than has usually been done in connection with the study of the sun, we can be certain that we should not expect in the small systems like ER Orionis and RZ Cassiopeiae as large an effect as is found for the large systems like SX and RX Cassiopeiae.

It is interesting that this new effect is very large in comparison with already well-known effects in eclipsing systems—the reflection, periastron, gravitation, ellipticity and alignment effects. In fact, for some systems it is larger than all these others put together.

In concluding the observational survey of our problem from a purely photometric point of view, it is only proper that some spectroscopic results should be mentioned. Struve at Yerkes and McDonald observatories was able to establish the motion of the enveloping atoms around the components of the two first systems of Table 1. If we consider his observations along with the photometric ones, we can see that the interplay of the components and their atmospheres during the two eclipses (visual and photographic) is correlated with the velocities of hydrogen and metallic atoms. The work at McDonald and at Harvard was entirely independent, yet each leads to the same results, being obtained in supplementary fields. And the spectroscopic work leads to the conclusion that the edgeless effects just described are associated with the possession of thick atmospheres.

Photometrically we observed an integrated effect, while spectroscopically the velocities of individual atoms in the thick atmosphere are observed. For some of the systems of the table large spurious eccentricities of the orbit are obtained for the blue component, while photometric results give a circular orbit. A small difference in the eccentricities has been known for a long time and it has been recently ascribed by Sterne and by Kopal to the effect of gravitation. In the light of this new effect of the thick atmosphere, the phenomenon may receive another explanation.

(4) *Theory of Thick Atmosphere.* It must be said at the outset that theoretically the idea of the elusiveness of the radius has been developed as early as 1934 by Kosirev with a specific application to the peculiar Wolf-Rayet and P-Cygni stars. Practically at the same time Chandrasekhar has developed the general theory of thick atmospheres. In other words, it seems that theoretically everything is ready for the physical approach to our problem. Following this theory, Whipple and Payne-Gaposchkin made a theoretical application to the expanding envelopes of Novae. It is needless to say that the stars which Kosirev and the above-mentioned authors considered are in many ways abnormal, although it seems that their abnormality is not so gross as has been thought twenty years ago. But if a star is conceived, not with a sharp edge but with rather diffuse surroundings, the theory will be applicable to many stars.

If we write, in accordance with Kosirev and Chandrasekhar, that the density gradient in the thick atmosphere has the general form

$$\tau \sim 1/r^n$$

where τ is the so-called optical depth, r is the radius of the star at the optical depth unity, and n a constant which has to be evaluated from other considerations, then for the normal atmosphere like that of the sun, n will have a value much larger than 1.0 (probably around 3 or 4), and for Wolf-Rayet stars n is close to 1.5, as follows from the work of Kosirev. As we go on taking different values of n, especially between 1.1 and 3.0 we obtain many gradations of the elusiveness of radii. Kosirev and Chandrasekhar have shown that the problem of the transfer of radiation has a solution for such atmospheres, which is of more general form than it is for the sun.

Payne-Gaposchkin and the author have recently evaluated the distribution of brightness over the disc (or whatever it may be called) of stars with such thick

atmospheres. The brightness depends on the above-mentioned n, the wave-length, the initial temperature, the distance from the center and the angle of sight. Our interest was chiefly confined to showing whether or not the theoretically predicted eclipses will have a dependence on the wave-length in the same sense as observed. The application was made to thirty-six cases, depending on difference in brightness and size of the components, n and on wave-length. It may be mentioned before publication that the theoretical results seem to be in full agreement with the observations. The photographic minimum is narrower than the visual. Of course, in a strict sense, both eclipses begin at the same time, but the distribution of the brightness over the disc in the photographic light is so different that the eclipse apparently begins much later. It would follow from this that the usual law of darkening towards the limb is only a limited case of this general distribution of the brightness over the disc with the thick atmosphere.

It is evident that the real observational results are more complicated than we can now theoretically handle. There is a serious question about the effect of ellipticity, and if we remember that the thick atmospheres of the two components may fill the whole space between the components, so that a great distortion in the isophotes and in velocities of atoms can be expected, the problem is indeed complicated. Then there is the inherent difference between the two components in some systems. It seems, however, that there is no doubt that the first application of the theory to the observed difference in the light curves has met with some success.

(5) *Conclusions.* The theory of thick atmosphere of Kosirev and Chandrasekhar, the spectroscopic observations of Struve and our photometric results seem to indicate that elusiveness of the radius is a more general phenomenon than has previously been thought.

The application of such an idea may have a wide scope and it may be that some observations on peculiar stars with envelopes, on large eclipsing variables like VV Cephei, ζ Aurigae and others or even on new stars (as with the duplicity of Nova Herculis) may receive a new explanation. Some other branches of astronomical research may also be influenced.

Since this effect has been found from the comparison of the visual with the photographic light curve, the visual observer of eclipsing variables will probably find a new stimulus. In the last decade many visual observations were considered unnecessary because of the ease and richness of the photographic work. Now the visual observations should probably not be confined to fixing an epoch of minimum, but will have another and more physical meaning. It is worth while to mention that the comparison in two wave-lengths does not need the basic photometry of the zero point, only of scale. It would seem that some revision of the sizes of large stars will be in order. Some peculiarities in their characteristics may be explained through the recognition of this edgeless effect.

It may also be that the internal constitution may receive a modified approach, for of the three fundamental parameters, two are becoming less definite, or have to be more precisely defined. If the effect is general, a great deal of work will probably be done in the future to determine the degree of thickness (the number n) in order to approach our established methods in computations of eclipsing variables with the inclusion of this effect.

In a recent communication Sir Arthur Eddington remarks with his usual simplicity and profundity that in our problem the conception of "occultation" radius and "bright" radius of a star should be kept apart, and though the problem is probably complicated this difference in the conceptions may contain a valuable element of bridging the new elusiveness of the radius with the old hard and fast conception of it.

OBITUARY

JAMES ALEXANDER SHOHAT

JAMES ALEXANDER SHOHAT, professor of mathematics at the University of Pennsylvania, died in the University Hospital on October 8, 1944, after an illness of three months. The cause of his death was bacterial endocarditis.

Professor Shohat was born in Brest-Litovsk, Russia, on November 18, 1886. He graduated from the University of Petrograd in 1910. He continued graduate studies there and in 1922 was awarded the degree of master of pure mathematics.

In 1922 he married Nadiaschda W. Galli, a physicist who later taught in the Physics Department of the University of Michigan, Mount Holyoke College, Rockford College and Bryn Mawr College. He and Mrs. Shohat came to the United States in 1923. He became a United States citizen in 1929.

From 1913 to 1917 he was an instructor in mathematics at the Polytechnic Institute, Petrograd. From 1917 to 1921 he was professor at the University of Ekatherineburg and from 1921 to 1923 at the Pedagogical Institute of Petrograd.

When he first came to the United States, he was an assistant in mathematics at the University of Chicago.

From 1924 to 1929 he was assistant professor of mathematics at the University of Michigan. He spent the year 1929–1930 doing research at the Institut Henri Poincaré, Paris. In 1930 he became an assistant professor at the University of Pennsylvania. He was promoted to an associate professorship in 1936 and to a full professorship in 1942.

He was a member of the American Mathematical Society, the Mathematical Association of America, the Institute of Mathematical Statistics and a fellow of the American Association for the Advancement of Science. For the past four years he was associate editor of the *Bulletin of the American Mathematical Society*.

The main field of his research was that of orthogonal polynomials, on which he had written numerous papers while still in Russia. He continued very active in this work after coming to America. His many publications in American and foreign mathematical journals form an important contribution to classical analysis. He was an inspiring lecturer and interested many graduate students in research problems under his direction. The following took doctorates at the University of Pennsylvania under his guidance: R. P. Bailey, W. Lawton, C. J. Rees, H. M. Schwartz, J. Sherman, Vivian Spencer, M. S. Webster and C. Winston. He was deeply devoted to his doctors; he was never satisfied with their mere satisfaction of the research requirements for the doctorate but followed their further careers with many suggestions as to problems and with advice leading to their solution.

He was chairman of a committee of the National Research Council on Bibliography of Orthogonal Polynomials. The other members of the committee were Einar Hille, of Yale University, and J. L. Walsh, of Harvard University. The work of this committee resulted in the publication in book form in 1940 of an excellent bibliography which is an invaluable aid to research workers in orthogonal polynomials.

In 1931 he published a monograph "Théorie Générale des Polynomes Orthogonaux de Tchebichef" in the series, Mémorial des Sciences Mathématiques. He planned a sequel to the above monograph, and a portion of the material for the same is found among his unpublished papers. In 1943 he and J. D. Tamarkin, of Brown University, published "The Problem of Moments," the first volume of the new series of monographs, Mathematical Surveys, published by the American Mathematical Society.

Dr. Shohat was interested in applied mathematics, and his course on higher mathematics for the solution of engineering problems attracted numerous engineers and physicists connected with a large number of industrial organizations in the Philadelphia area. In this manner he became interested in Van der Pol's Equation, which was the subject of his last two published papers. Just before his last illness he finished the translation from the Russian of Kryloff's "Differential Equations for Mathematical Physics and their Application to Engineering." This translation will be published posthumously.

He had an intense patriotism for his adopted country and was vitally interested in doing everything possible to aid in the successful prosecution of the war. During the last year of his life, in addition to his own numerous research activities related to pure mathematics, he acted as a consultant for the Navy Department in connection with the work of the David Taylor Model Basin.

A burning enthusiasm for mathematical research, a deep interest in the work of his students, both graduate and undergraduate, an earnest desire for the improvement of all opportunities for graduate study made Professor Shohat a forceful figure in the scientific work at the University of Pennsylvania. He was a true friend and a loyal colleague.

J. R. KLINE

RECENT DEATHS

DR. MAURICE COLE TANQUARY, since 1928 professor of apiculture at the University of Minnesota, died on October 25. He was sixty-two years old.

DR. EVANDER FRANCIS KELLY, of the University of Maryland, since 1926 secretary of the American Pharmaceutical Association, died on October 27 at the age of sixty-five years.

DR. MARTHA BUNTING died on October 13 in her eighty-third year. She had taught biology at Goucher College and in high schools in Philadelphia and New York. Subsequently, at the University of Pennsylvania she served as research assistant in the Medical School for six or seven years, and later was a research fellow for a number of years in the department of zoology.

DR. RICHARD B. HENDERSON, of the National Institute of Health at Washington, D. C., died on October 20 at the age of thirty-two years. He was engaged at the request of military authorities in perfecting a vaccine to combat "scrub typhus." During the course of this work he contracted the disease.

HOWARD PALMER, known for his explorations of the Canadian Rockies, died on October 24 in his sixty-first year.

DR. CHARLES G. BARKLA, professor of natural philosophy at the University of Edinburgh, died on October 23 at the age of seventy-three years.

SCIENTIFIC EVENTS

THE AID OF SCIENCE IN INDIAN DEVELOPMENT

AN article by Professor A. V. Hill, M.P., secretary of the Royal Society, on the role of science in the development of India, is printed in *The Times*, London, for September 20. He gives the following particulars of the advances made during the present century and particularly during the last fifteen years.

Science in India, in spite of relative poverty and isolation, has shown remarkable progress. The standards of scientific research are rising steadily—there are now seven Indian F.R.S.s. and plenty more coming on—and the educated public has become notably aware of science as an essential ingredient in modern civilization.

On the unofficial side, the foundation of national scientific bodies is a good index of healthy growth. Of specialist societies, those in geology (1906), in mathematics (1907), in botany (1921), in chemistry (1924) and in physics, physiology and soil science (1934) may be mentioned; of general scientific societies, the Indian Science Congress Association (1914) and the National Institute of Sciences (1935) founded respectively on the model of the British Association and the Royal Society. On the government or official side the greatest recent developments have been in agricultural and industrial research and in connection with medicine, nutrition and war equipment. The Imperial Agricultural Research Institute was founded at Pusa in Bihar in 1905 and transferred to Delhi in 1936, the Imperial Council of Agricultural Research was established in 1929, and many research stations and organizations have been set up all over India; the Board of Scientific and Industrial Research was founded in 1940 and considerable developments are now in prospect, for example, the building of national laboratories, for physics, chemistry and the like; the admirable Ordnance Laboratories at Cawnpore were opened in 1943.

THE PROPOSED MEDICAL-DENTAL CENTER AT NEW YORK UNIVERSITY

IN the course of an address made on October 26 by Dr. Harry Woodburn Chase, president of New York University, at a dinner in honor of Dr. Samuel A. Brown and Dr. George B. Wallace, of the College of Medicine, both of whom had reached the age of seventy years, he outlined plans for the development after the war of a medical-dental center in the Bellevue area by the New York University College of Medicine in cooperation with the City of New York and Bellevue Hospital.

The plan as described by Dr. Chase provides for three units:

I. *A University Hospital and Diagnostic Clinic* which would offer all methods of modern diagnosis, together with in-patient facilities, to families of the middle-low income group. Such a health center would be in line with the newest concepts of the prevention of ill health. Under the guidance of some of the leading professors in medicine, it would open up a new field of study of the environmental and social factors which lead to the earliest signs of disease. It would place emphasis upon the maintenance of health and upon preventive medicine as applied to the individual. It would be a center of coordination for all available medical services, including those of physicians, nurses and social service workers. It would bring together the problems of medicine with those of business and industry in an attempt to establish for each patient his optimum performance in work in relation to his health.

II. *An Institute of Medical Sciences* where the clinical departments of medicine can offer opportunities to younger men for study and research in specially important fields, for only by a concentrated and fully coordinated drive in certain specific directions will new advances emerge. Obviously no medical center can cover adequately all phases of medical research. The plans for this new center therefore envision the creation of special institutes and laboratories of research in those selected fields in which the College of Medicine has gained eminence and in which the recognized leaders are members of the Faculty of Medicine. It is in line with the established willingness of the College of Medicine to break with tradition that the special institutes selected will be essentially unique in this country.

III. *A Medical Library*, Hall of Residence and a large Auditorium for Post-graduate Teaching to seat five hundred, "a place where the traditions of medicine can flourish and to which, after graduation, physicians can turn with pride for continued inspiration." This building will be the keystone of the entire center in graduate and undergraduate medical education.

THE BIOLOGICAL STATION OF THE UNIVERSITY OF MICHIGAN

THE many friends of the Biological Station of the University of Michigan will be pleased to know that it has survived the war crisis. It has recently completed its thirty-sixth summer at its permanent site near Cheboygan, Mich. Though in 1942 and 1943 it suffered a drop in enrollment, and during the past two summers temporarily lost three of its regular faculty members to the war effort, the past summer saw an increase in enrollment to ninety-four students and investigators. With the anticipated return next summer of its entire staff of twelve professors, it is expected that the station will again offer a full program of courses and will be prepared to serve a maximum of one hundred and twenty students and investigators.

The course in Natural History of the Invertebrates, unique in its nature and scope, under Professor F. E. Eggleton, of the University of Michigan, will again

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be offered; Professor P. S. Welch, of the University of Michigan, a pioneer and leader in limnological studies, will continue his work in that field; and Professor C. W. Creaser, of Wayne University, will again teach courses in the natural history of the non-avian vertebrates.

Ornithological studies, under the direction of Professor O. S. Pettingill, Jr., of Carleton College, have gained remarkable favor during the past seven years and are attracting a promising group of professional as well as many amateur ornithologists.

The station long has enjoyed an excellent record in teaching and research in animal parasitology under the leadership of Professors W. W. Cort, of the Johns Hopkins University, and L. J. Thomas, of the University of Illinois. Because of the absence of Professor Cort during the summers of 1943 and 1944 the course in helminthology was suspended and the emphasis on research in animal parasitology was reduced. With his expected return in 1945 it is planned to restore that course with its aim of training for research in parasitology, and to renew the emphasis of pre-war years on research in that field.

Teaching and research in general entomology under the direction of Professor H. B. Hungerford, of the University of Kansas, has been of high quality for many years. This work will be continued.

Soon after we were plunged into the war, it was recognized that the military position and post-war responsibilities of the United States in the Tropics and the Orient would require an expansion of the American training program in medical zoology. Accordingly, a course in medical entomology and human parasitology, taught jointly by Professors Hungerford and Thomas, was instituted in 1943. It is planned to continue this course as an important element in the training of entomologists and parasitologists, and particularly of prospective teachers and practitioners in sanitary science and medicine.

With a staff of four botanists—Professors C. D. La Rue and W. C. Steere, of the University of Michigan; F. C. Gates, of Kansas State College, and G. W. Prescott, of Albion College, all with extensive field experience in the tropics, it is planned to add a course in field methods with special attention to tropical conditions, a course which it is believed will be useful to all who expect to do any type of field work in the tropics.

A. H. STOCKARD,
Director

AWARD OF THE NOBEL PRIZES IN PHYSIOLOGY AND MEDICINE

AN Associated Press dispatch from Stockholm dated October 26 announces the award of the Nobel Prizes in physiology and medicine for 1943 and 1944. The recipients were chosen by the Caroline Medical Institute in Stockholm.

The 1943 award, made after a year's delay, is shared by Dr. Edward Adelbert Doisy, professor of biochemistry in the School of Medicine of St. Louis University, and Dr. Henrik Dam, of Copenhagen, now at Strong Memorial Hospital, Rochester, in recognition of their discovery of the chemical nature of the K vitamin.

The 1944 award has been conferred on Dr. Joseph Erlanger, professor of physiology at the School of Medicine of Washington University, St. Louis, and on Dr. Herbert Spencer Gasser, director of the Rockefeller Institute for Medical Research, New York, for their work on the functions of the individual nerve threads. The awards both for 1943 and 1944 will be divided between two recipients.

The 1943 award is worth 123,690 kroner, about $29,500, and the award for 1944 is worth 12,841 kroner, about $29,059.

SCIENTIFIC NOTES AND NEWS

THE John Scott Medal and Award of the Franklin Institute, which was conferred on Sir Alexander Fleming in recognition of his study of penicillin, was accepted on his behalf on October 23 by the Earl of Halifax, British Ambassador to the United States, at the William Penn tercentenary anniversary in Philadelphia.

THE Norman Medal of the American Society of Civil Engineers has been awarded to Dr. Ralph B. Peck, research assistant professor of soil mechanics at the University of Illinois, for his paper on "Earth Pressure Measurements in Open Cuts of the Chicago Subway." The Croes Medal, which since 1912 has been given for the paper "next in order of merit to the paper to which the Norman Medal is awarded," will be given to Dr. Nathan M. Newmark, research professor in civil engineering, also of the University of Illinois, now on leave of absence for service with the army in the Pacific, for his paper entitled "Numerical Procedure for Computing Deflections, Moments and Buckling Loads."

THE Secretary of War has awarded the Emblem for Exceptional Civilian Service to Dr. Walter V. Bingham who, as chief psychologist and chairman of the Committee on Classification of Military Personnel Advisory to The Adjutant General, has been instrumental in bringing the science of psychology effectively to bear on the Army's problems of manpower utilization.

The emblem and citation were presented on October 25 by Major General James A. Ulio, The Adjutant General, at a brief ceremony in the Pentagon.

AT a luncheon in Washington on October 19 in honor of Charles J. Brand, executive secretary and treasurer of the Chemical Fertilizer Association and chairman of the American Committee of the International Institute of Agriculture, Marcial Mora, Chilean Ambassador to the United States, presented him with the decoration of Commander of the Chilean Order of Al Merito. The decoration was conferred in recognition of his "services to world agriculture and to Chile, particularly in connection with the development of its nitrate resources for fertilizer."

THE annual Progress Medal of the Society of Motion Picture Engineers was presented on October 17 at the fifty-sixth semi-annual technical conference at the Hotel Pennsylvania, New York City, to George Capstaff, of the research laboratories of the Eastman Kodak Company, for his pioneer work in amateur, professional and color cinematography. At this meeting Donald E. Hyndman, vice-president for engineering, was elected president of the society, succeeding Herbert Griffin.

THE council of the Royal Aeronautical Society, London, has awarded to Air Commodore Frank Whittle, a fellow of the society, its gold medal for inventing jet propulsion.

UNION COLLEGE conferred on October 22 the doctorate of laws on Dr. Charles E. Wilson, president of the General Electric Company and a former vice-chairman of the War Production Board. Dr. Wilson made the graduating address.

THE honorary degree of doctor of science was conferred on October 28 at the commencement exercises of the Stevens Institute of Technology on Dr. Robert F. Mehl, director of the Metals Research Laboratory, professor and head of the department of metallurgical engineering of the Carnegie Institute of Technology, Pittsburgh, in recognition of "his attainments in metallurgy and his contribution to education in Brazil and the furtherance of inter-American friendship." Dr. Mehl recently spent three months in Brazil where he lectured on metallurgy at universities and visited Brazilian metal industries.

THE seventy-fifth birthday of Vladimir Komarov, president of the Academy of Sciences of the USSR, and the fiftieth anniversary of his activities as a scientific worker were celebrated on October 15.

DR. L. EMMETT HOLT, JR., associate professor of pediatrics at the Johns Hopkins Medical School, has been appointed professor of pediatrics at the New York University College of Medicine and director of the Pediatrics Service at Bellevue Hospital. He succeeds Dr. James L. Wilson, who has joined the medical faculty of the University of Michigan.

PROFESSOR ARTHUR F. JOHNSON, since June 1, 1941, marine consultant to government agencies concerned with shipping, has resumed his post as professor of mechanical engineering at the George Washington University after completing three years of special duty with the Maritime Commission and the War Shipping Administration. His services were loaned to the government by the university.

DR. ROBERT K. ENDERS, who has been on leave of absence from the department of zoology of Swarthmore College for the past year, returned to the college on November 1. He has been promoted from an associate professorship to a full professorship of zoology.

AT the Woman's Medical College of Pennsylvania, Dr. Lloyd D. Seager has been appointed professor of pharmacology, and Dr. James O. Brown has been appointed associate professor of anatomy and acting head of the department.

AT the School of Medicine of Western Reserve University, Dr. Harold F. Chase, of the College of Medicine of Wayne University, and Dr. Ernest Bueding, of the New York University School of Medicine, have been appointed to assistant professorships of pharmacology.

DR. ORLAN M. ARNOLD, assistant professor of chemistry at the Rensselaer Polytechnic Institute, has been appointed head of the Division of Physical Chemical Research at Detroit of the Chrysler Corporation.

LIEUTENANT JOHN B. LUCKE, USNR, head of the department of geology at the University of Connecticut, has leave of absence and has been assigned to duty as photographic interpreter abroad. He may be addressed at J.I.C.P.O.A. Navy 128, Fleet Post Office, San Francisco, Calif.

MAJOR ALLYN C. SWINNERTON, on leave from the department of geology of Antioch College, has recently been transferred from the Office of the Chief Signal Officer, Washington, D. C., where he has been stationed for over a year as officer in charge of the Quartz Crystal Section of the Engineering and Technical Service. He has been made director of the Long Branch Signal Laboratory of the Signal Corps Ground Signal Agency in the Fort Monmouth, N. J., area.

DR. HARVEY A. ZINSZER, professor of physics and astronomy at the Kansas State College at Fort Hays, has leave of absence to assist in the pre-radar course for army and navy officers at the Cruft Laboratory, Harvard University.

DR. EUGENE KISCH, associate in orthopedic surgery

at the Hospital for Joint Diseases at Far Rockaway, N. Y., left for Brazil in October. He has been invited by the Brazilian Society for Tuberculosis to give lectures on bone and joint tuberculosis and to attend conferences in Rio de Janeiro, São Paulo and Bella Horizonte.

BRIGADIER GENERAL J. R. REES, consultant psychiatrist to the British Army, will deliver the Salmon Lectures for 1944 at the New York Academy of Medicine at 8:30 P.M., on November 20, 21 and 22. The lectures are—November 20, "The Frontiers Extend," a review of the experiences of the war in so far as they open up new psychiatric responsibilities; November 21, "Opportunities Emerge," and November 22, "The Way Ahead." Following these lectures he will tour the country and plans to present condensations of the three Salmon Lectures at Los Angeles, Boston and Montreal.

DR. SELMAN A. WAKSMAN, microbiologist, of the New Jersey Agricultural Experiment Station, will give the second Harvey Society Lecture of the current series at the New York Academy of Medicine on November 16. He will speak on "The Production and Nature of Antibiotic Substances."

DR. HENRY B. WARD, professor of zoology emeritus of the University of Illinois, will deliver on November 13 the annual D. J. Davis Lecture at the College of Medicine of the university. The subject of his lecture will be "Medical Zoology in America's First Century."

PROFESSOR ALEXANDER SILVERMAN, of the University of Pittsburgh, will lecture on "Glass After the War" on November 6 before the St. Louis Section of the American Chemical Society; on November 8, before the Kansas City Section; on November 9, before the Wichita Section; and on November 11, before the section at Tulsa, Oklahoma.

DR. LEON J. COLE, professor of genetics at the University of Wisconsin, lectured on October 3 at Cornell University on "The Origin of Variability in Domestic Animals." The lecture was sponsored by the Schiff lecture foundation.

A MEETING of the National Academy of Sciences will be held on November 15 and 16 in the auditorium of the U. S. National Museum, Washington. The subject of the meeting will be "Science and War."

THE annual meetings of the American Society of Agronomy and of the Soil Science Society of America, planned from November 15 to 17 at Cincinnati, Ohio, have been cancelled.

MENTAL hygiene problems of peace, international amity, industry and reconversion, rehabilitation of veterans, race relationships and the community generally will be considered at the thirty-fifth annual meeting of the National Committee for Mental Hygiene, which will be held on November 8 and 9 at the Hotel Pennsylvania, New York City. Morning and afternoon sessions will be held. There will be a luncheon meeting for the executives of the State Mental Hygiene Societies on Wednesday; the annual luncheon of the National Committee will be given on Thursday. At each session about half the time will be reserved for discussion from the floor.

THE Army Ordnance Award for "scientific and engineering achievement" was presented on October 19 to the American Society of Metals at the recent annual congress in session at Cleveland.

THE sum of $25,000 for cancer research is bequeathed to Cornell University by the will of the late Henry R. Ickelheimer, a private banker, and $42,500 is left to Mount Sinai Hospital, New York City.

AN endowment for a Helen Putnam Fellowship for Advanced Research by mature women scholars in the fields of genetics or mental health has been given to Radcliffe College. The stipend of the fellowship is $1,750. It will be awarded each year for an eleven-month period to a resident fellow and will also provide a subsidy for the publication of manuscripts approved by the Radcliffe Committee on Publications. Appointments will be limited to candidates submitting a plan of research that is already under way. It is hoped that the first award will be made on December 1, but if a candidate is not chosen before that time, the fellowship will not be given until next year. Applications for the award should be addressed to the president of the college, Dr. W. K. Jordan.

INTENSIVE one-week courses on the medical, surgical and dental aspects of industrial hygiene have been arranged from October 30 to December 16 at the DeLamar Institute of Public Health of Columbia University, of which Dr. Harry S. Mustard is director. The curriculum is planned to aid in an expanding program for teaching, practice and research in various aspects of public health. Registration is limited to physicians, dentists, engineers, chemists and others professionally qualified. Studies in dermatoses, their diagnosis and control, began on October 30; general health in industry will begin on November 13; metals and their industrial uses and dangers on November 27; the administrative aspects of industrial hygiene on December 4; and dental problems and practices in the field of industrial hygiene on December 11.

THE Nuffield Foundation has allocated £10,000 for ten years to the University of London for the found-

ing of a chair of child health. A postgraduate institute of child health is to be established, associated with the British Postgraduate Medical School.

Nature states that on the recommendation of a special committee, the Council of the University of Leeds has adopted a plan for the establishment of an Ophthalmological Research Center. As soon as the necessary funds are available, the council will proceed to the appointment of research fellows to work on special problems concerned with the prevention and cure of blindness and other diseases of the eye. X-ray equipment, the recently installed electron microscope and other facilities will be made available for the work in the university. The maintenance and development of the center will be in the hands of an Ophthalmological Research Advisory Committee.

IT is reported in *Industrial Standardization* that a new national standards association—the Asociación Chilena de Normas—has held a preliminary meeting and has appointed a provisional board of directors to serve until the final organization is completed. The meeting was sponsored by the Chilean Institute of Engineers and other important Chilean organizations. The provisional board of directors, in addition to its work of setting up the Asociación Chilena de Normas and opening the registration of members, is planning to organize technical committees for work on standards. Among the first subjects to be considered, it is expected, will be cartographic drawing, technical drawing, preferred numbers, tolerances, lumber and cement. The association is publishing a magazine on Chilean standards entitled *Normalizacion*.

DISCUSSION

DETERMINATIONS OF GEOGRAPHIC COORDINATES IN GREENLAND

A PAPER recently published in SCIENCE, on evidences of differential shifts in position of crustal masses, is of particular interest to geologists.[1] During the past twenty years certain comparative data on determinations of longtitude have been cited frequently in support of the concept that whole continents have "drifted" widely and perhaps are still in motion. Geologists realize, and Dr. Stetson reminds us, that verification of changing coordinates would not necessarily indicate movement of continental masses, since we have abundant evidence of translational displacement along thrust surfaces and strike-slip faults, some of which are still active. However, the observations to determine longitude at several points in Greenland have had especial interest, since stations have been occupied in both the eastern and western coastal areas, and the published results, if taken at their face value, seem to indicate progressive movement westward. Geologists in general are not competent to appraise these data critically. Therefore it is gratifying that an astronomer has examined the detailed publications from one of the earlier surveys, in an effort to determine the degree of reliability that can be accorded the results.

Dr. Stetson chose for careful study the data for latitude and longitude resulting from observations in 1870 by Börgen and Copeland at Sabine Island. An error in Stetson's identification of this island should be pointed out; he describes the location as "in the Melville Bay region, off the west coast of Greenland." No doubt this error results from a confusing duplication of names. Maps show southwest of Melville Bay, near latitude 75°26′N, longitude 60°W, a group of islets labeled "Sabine Islands." Sabine Island, visited by the explorer Sabine in 1823, lies off the *east* coast of Greenland near latitude 74°36′N longitude 19° W. This correction is not an essential item in the discussion to follow, but it seems desirable in the interest of accuracy.

Sabine, using the inaccurate methods of his day and probably with inferior equipment, made the first recorded observations to determine geographic coordinates of the island, in 1823. Börgen and Copeland failed to identify Sabine's observation point when in 1870 they arrived on the island as members of the Germania Expedition. They made determinations of latitude and longitude on a point which they believed to be within 100 meters of Sabine's location, but the admitted uncertainty makes valueless for scientific use any comparison with Sabine's results. In 1907 J. P. Koch occupied a station at Danmarkshafen, more than 200 miles farther north, and later ran a triangulation net to include the Sabine Island station of 1870. His values of longitude have been cited as evidence that Sabine Island moved westward 1,190 meters in the 37-year interval. Jelstrup, who in 1932 reoccupied the exact site used by Börgen and Copeland in 1870, was the first to employ modern radio time-signals on the island. He rejected all earlier results except those of 1870, and obtained a value for longitude which appears to indicate a westward shift amounting to 615 meters during the 62-year interval. If we should accept Koch's results as equally reliable—and some advocates of the continental-drift hypothesis do cite them as valid evidence—it would be necessary to conclude that the Sabine Island station moved westward 1,190 meters between 1870 and 1907, and retreated eastward 575 meters in the 25 years following 1907.

[1] Harlan T. Stetson, SCIENCE, 100: 87–93, 113–117, 1944.

Stetson accepts Jelstrup's results as correct within a limit of error not greater than 20 meters, and scrutinizes the original data of Börgen and Copeland, whose longitude values had to be based on lunar culminations and star occultations. He concludes that the probable error in the determinations, expressed in linear measure, can be no more than 80 meters. Since there is a discrepancy of 615 meters between Jelstrup's longitude position and the earlier value, it appears that the longitude of Sabine Island must have changed during 62 years by at least some 500 meters. When we add to this a discrepancy of about 100 meters in latitude between the two determinations, the net linear change in position amounts to nearly a third of a mile, in a direction somewhat south of west. Stetson discounts this figure by a large fraction, and accepts "seven hundred to eight hundred feet" as the minimum shift indicated by comparison of the two sets of data. This analysis by a competent astronomer must receive serious consideration. However, the layman in such matters is left with an uncomfortable feeling that the mean probable error may be given undue weight in treating a single set of data into which may enter inaccuracies from some unsuspected source. I confess to a strong skepticism based on comparison with developments at Kornok, another Greenland station that has figured prominently in the problem of shifting coordinates.

Kornok (Oornoq) lies on the Godthaabfiord in western Greenland, near latitude 64°32′N, longitude 51°02′W. Observations to determine coordinates at this location were made by Falbe and Blume in 1863. Twenty years later von Ryder reoccupied the station, and obtained a value for longitude more than 400 meters *east* of that reported by the earlier expedition. Both parties of course employed lunar observations for comparisons of time. In 1922 Jensen, using modern radio time-signals, reported a longitude value about 1,200 meters *west* of that obtained by von Ryder. In 1927 the Danish Geodetic Institute again occupied the station, and announced a value about 180 meters west of Jensen's. Wegener[2] and du Toit[3] lay especial emphasis on comparative results of the two modern determinations, which they interpret as an indication that Greenland moved westward in the 5-year interval at an average annual rate of 36 meters. However, the Danish Institute repeated the observations in 1936, and obtained a longitude value essentially identical with that of 1927.[4] In his published statement the director of the institute does not specifically mention Jensen's value of 1922, but presumably he includes it in his general opinion that "the deviations of the old observations from the new ones are the result of observation errors."

If we should accept the results of all observations at Kornok, the behavior indicated for that part of Greenland would seem erratic in the extreme. The story would be as follows: Between 1863 and 1883 the station moved eastward more than 400 meters, an average of more than 20 meters annually. From 1883 to 1922 movement was in the reverse direction, at an average rate of nearly 31 meters per year. During the next five years the westward drift continued at the faster pace of 36 meters yearly. What may have happened after 1927 is a matter for some speculation. Either the movement stopped abruptly, and had not been resumed nine years later; or sometime after 1927 the direction of drift again reversed to eastward, and in 1936 there had been a return to the exact longitude of 1927. Such a succession of events may be conceivable. It seems significant, however, that all evidence of shifting position vanished in the nine-year interval between modern observations that are vouched for as accurate by a highly reputable geodetic organization.

It would be interesting to have a competent analysis of the data from the early observations at Kornok, similar to the analysis of the Sabine data by Stetson. The methods used at the two positions were essentially the same, but of course the results in one case may prove to be less reliable than in the other. However, criticisms of conclusions based on the nineteenth-century determinations at the two stations have been answered repeatedly with the statement that the amount of apparent change in longitude is many times the probable error inherent in the observational methods employed. Similarly J. P. Koch claimed that any error involved in the triangulation by which he related the Sabine station to Danmarkshafen must have been less than the probable error of the longitude determinations. Whatever the theoretical merits of such claims, we shall look forward to eventual check of the coordinates at Sabine Island by the same precise methods that have been used at Kornok.

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[2] Alfred Wegener, "Die Entstehung der Kontinente und Ozeane," 4th Edition, Braunschweig, 1929, pp. 27–29.

[3] A. L. du Toit, "Our Wandering Continents," London, 1937, p. 300.

[4] N. E. Nörland, "Astronomical Longitude and Azimuth Determinations," *Roy. Astr. Soc. Monthly Notices*, Vol. 97, 1937, pp. 505–6.

THE GENERIC AND SPECIFIC TRIVIAL NAMES OF THE TERTIAN AND QUARTAN MALARIA PARASITES

THE Official List of Generic Names in Zoology was established by the International Congress of Zoology in order to promote stability in zoological nomencla-

ture by placing on record the correct names of the principal genera in each of the Classes and Orders of the Animal Kingdom, together with their type species. Hitherto names have been placed on the Official List in Opinions rendered by the International Commission on Zoological Nomenclature, but in 1943, the International Commission decided that it was desirable to make the Official List more readily available and accordingly decided to publish it as soon as possible in convenient book form and with a full index. The preparation of the Official List for publication in this way, which was begun in the autumn of 1943, involved the checking of all the relevant bibliographical and other references to the generic names concerned and their type species. In the course of this work, errors were detected in a number of the Opinions containing decisions relating to the Official List. These errors are being brought at once to the attention of the International Commission with a view to their rendering an Opinion as soon as possible containing such rectifications as may be necessary.

Among the errors detected were errors in the entries in Opinion 104 (published in 1928) relating to the author's name and date of publication of the generic name for the Malignant Tertian Malaria Parasite (*Laverania* Feletti and Grassi, 1889). Further, in the case both of this name and of that for the Quartan Parasite (*Plasmodium* Marchiafava and Celli, 1885) the type species was found to have been cited under a name which was not the correct name under the International Code of Zoological Nomenclature.

The names of these parasites, as recorded in Opinion 104, are the names now universally employed for these species in the enormous medical and technical literature relating to malaria, and it would clearly be as wrong as it would be impracticable to attempt to introduce changes in such names merely on grounds of zoological nomenclature. In the present case such changes would be particularly undesirable, since they would involve the transfer of the specific trivial name "*malariae*" from the Quartan Parasite (on which it was bestowed by Grassi and Feletti, 1890), by which name this species is universally known, to the Malignant Tertian Parasite on which in 1881 it had been independently bestowed by Laveran (and by which name this species is never called). Transfers of trivial names in this way cause great confusion and the only solution in such a case is for the International Commission to use their plenary powers to suspend the rules in order to validate the names currently in use.

It was accordingly decided early in 1943 to invite the International Commission to deal with this question under their plenary powers and, for this purpose, a thorough investigation into the highly complicated literature of these names was made, with the assistance of Sir Rickard Christophers and Brigadier J. Sinton, whose paper, "The correct name of the Malignant Tertian Malaria Parasite," published in 1938,[1] must form the starting point of any work on this subject. In the course of this investigation, names previously overlooked were brought to light and other unsuspected nomenclatorial difficulties were disclosed. A paper setting out in detail the present position under the International Code and containing recommendations to the commission for placing the whole matter on a satisfactory footing has been prepared and will appear in the next part of the *Bulletin of Zoological Nomenclature*, the official organ of the International Commission on Zoological Nomenclature.

Quite recently the officer in charge of malaria control in war areas, Atlanta, Georgia, U. S. A., communicated to the International Commission an application prepared by Drs. Curtis W. Sabrosky and Robert L. Usinger, U. S. Public Health Service, drawing attention to the errors in Opinion 104 and requesting the International Commission to use their plenary powers to suspend the rules for the purpose of validating existing nomenclatorial practice in regard to these parasites. This application has since been published in the issue of SCIENCE for September 1, 1944. It is extremely gratifying to the executive committee of the International Committee to find that malariologists in the United States, working independently, have reached substantially identical conclusions in regard to this matter, since this should greatly facilitate the early adoption by the International Commission of an Opinion setting this matter at rest once and for all.

In order to secure the widest support for the action proposed to be taken, the executive committee, on behalf of the International Commission, invite expressions of opinion from specialists concerned in any aspect of the malaria problem. Such communications, which should be addressed to the International Commission on Zoological Nomenclature at their Publications Office, at 41, Queen's Gate, London, S.W.7., will at once be published in the commission's official organ, the *Bulletin of Zoological Nomenclature*, in order that the whole of the material relating to this case may be before the commissioners when reaching their decision.

FRANCIS HEMMING,
Secretary

THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

[1] *Brit. Med. Jour.*, 2: 1130–1134, 1938.

WHAT IS HEREDITY?

THE discussion in SCIENCE[1] precipitated by the statement of Professor Dice, that "the characters of man that are inherited include not only his anatomical features, but also his physiology and his psychology," has served to emphasize the need of clarification of the concept of heredity. Expressions like "inherited skin color" or "inherited behavior" are figures of speech which are misleading if taken literally. The relations between heredity and characters or traits of the developing organism are dynamic. Heredity does not transmit skin colors or behaviors; it determines the responses, the norm of reaction, of the organism to its environment. The same heredity in different environments may give rise to different skin colors and behaviors. Diabetes mellitus is inherited, but injections of insulin remove the manifestations of this physiological disorder. Insulin obviously does not "cure" or alter the defective heredity; but this heredity responds to an environment which contains insulin by normal carbohydrate metabolism. Now, it is not too much to suppose that a diabetic will in some cases behave differently from a non-diabetic. The former is likely to adhere to a certain regimen which might, for example, limit his social activities. He may be reluctant to embark on a journey in parts where he is not sure to find a supply of insulin. His whole personality may acquire a special cast which in the last analysis is due to the possession of genes for diabetes. A Negro, or for that matter anybody having a highly pigmented skin, may be diffident or aggressive in a social environment in which his pigmentation subjects him to discrimination and handicaps. This "psychology" may correctly be called inherited, just as the skin color is called inherited, although in some people the skin color is greatly changed by exposure to sunlight. Heredity which causes the skin to be black and behavior self-conscious may result in a quite different behavior in an environment where discrimination is absent.

Non-geneticists may feel disinclined to regard as hereditary a trait so plastic that it appears in some environments but not in others. Yet, all degrees of environmental plasticity occur. For example, the $A-a^{B}-a$ blood group genes produce the same "character" in all known environments. The outward manifestation of the genes for eye color slightly changes with age. The environmental dependence of stature, weight and skin color is obvious. Behavior is influenced so much by environmental variables, particularly training, social conditions and accumulated experience, that the genetic variable is frequently masked. The designation "hereditary" can not be restricted to traits which show a certain degree of constancy of expression. The degree of constancy is itself inconstant; introduction of insulin treatments made the expression of the genes for diabetes much more labile than it was. It may seem trite to remind that genes influence the development through chains of physiological reactions. The possibilities of controlling the gene manifestation will be greatly increased when these reactions become known. Theoretically, the action of any gene may be controlled. To say that man's psychology is inherited does not, by any stretch of imagination, mean that it is fixed and unalterable. We can not change our heredity directly, but heredity is not implacable destiny to which one must submit in resignation. We should seek for ourselves, and contrive for others, environments in which our heredities respond most favorably. If the genotypes of all men responded to every given environment by producing the same "psychology," we could say that psychic characters are not inherited. This, I take it, is not contended even by most confirmed environmentalists. On the other hand, the assertion that psychic characters are inherited does not preclude the possibility that we can, by proper manipulation of the environment, eventually achieve a complete control over them. Existence of inherited "race psychology" is a wholly separate problem. Races are defined as populations differing from each other in the incidence of certain genes. Physical characters suggest that there are all degrees of racial subdivision, beginning with social isolates, local populations and up to the major races the reality of which is not impaired by intermediate or doubtful groups. Theoretically, it is possible that, although genetic variation in psychic characters exists from individual to individual, the incidence of all the variants in the several races is alike. Secondly, it is possible that races differ in the incidence of some of these variants but that the differences are purely quantitative. Finally, it is possible that the differences are qualitative, and all individuals of one race possess certain genes which are always lacking in the other race, and *vice versa*. Not being a specialist, the writer can only say that a second-hand familiarity with the available evidence suggests that the evidence is quite insufficient and that the problem is best left open. But whatever its solution will prove to be, the environmental plasticity of psychic characters is so great that average differences between races will certainly be smaller than the amplitude of the intra-racial differences.

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[1] SCIENCE, 99: 457–461, 1944; *ibid.*, 100: 50–51; *ibid.*, 100: 146–147; *ibid.*, 100: 246–247.

SCIENTIFIC BOOKS

THE PATHOGENESIS OF TUBERCULOSIS

The Pathogenesis of Tuberculosis. By ARNOLD R. RICH. 1008 pp. 89 figures. Springfield, Ill.: Charles C Thomas. 1944. $10.50.

UNDER the concept of pathogenesis Dr. Rich evaluates and integrates more than 1,400 significant old and new contributions from various branches of experimental biology and medicine which throw light on the origin of tuberculosis, its progress, arrest and prevention. The material is organized in 21 chapters and includes a presentation of the underlying basic principles necessary for an understanding of the various topics, with an attempt to demarcate the boundaries of present knowledge in each instance.

Since Dr. Rich has contributed so much to the field of tuberculosis it is natural that he has formed opinions on most of the subjects discussed and hence his presentation is a marshalling of evidence for certain points of view. Most of his conclusions will probably be widely accepted. At times, however, it is questionable whether all will share his judgment.

Among the many views expressed by Dr. Rich, the following may be mentioned. The lipides of the tubercle bacillus are a factor in epithelioid cell formation, but the phosphatides thus far isolated are not the agents active in the body. No protein has as yet been isolated from the tubercle bacillus which induces the allergic hypersensitivity characteristic of the disease, though it produces anaphylactic sensitization. No toxin has been demonstrated from the tubercle bacillus to which the tissues of the non-tuberculous animal are sensitive. Necrosis in tuberculosis is due to an acquired sensitivity of the cells to the protein of the bacillus. No qualitative difference has as yet been demonstrated in the lipides, proteins or carbohydrates of mammalian tubercle bacilli of different virulence. The nature of virulence is unknown.

Although it has been demonstrated that the human type tubercle bacillus at first multiplies in the body of the rabbit before its destruction the author does not accept the view that the native resistance of the rabbit to this bacillus is acquired during the course of the infection. The tension of oxygen available in the different organs is considered a decisive factor in their resistance to the disease. He is convinced that races and individuals possess varying degrees of hereditary native resistance and different capacities to acquire lasting increased resistance as a result of experiencing the disease. He presents much suggestive data indicating that in man age and sex play an important role in resistance to tuberculosis. The native resistance of some white adults according to Rich may be sufficient to account for the localizing, slowly progressive tuberculosis characteristic of this period of life. Animal experiments with inbred rabbit families present suggestive evidence for this view. These chapters are beautifully illustrated by human pathological specimens and emphasized by interesting epidemiological statistics.

There is an excellent discussion of the differences and similarities between bacterial allergic sensitivity and anaphylactic sensitization to soluble proteins. According to Rich, allergic sensitivity in tuberculosis plays no role either in the fixation of the bacilli at the site of reinfection or in the suppression of their growth; its influence in the disease, if any, is deleterious. The reviewer holds that the evidence at hand indicates that allergy is not essential to the mechanism of acquired resistance, but it would be difficult to maintain that it may not aid in the resistance to the disease, *e.g.*, agglutinating antibodies can not be held responsible for the more effective fixation at the site of reinfection with tubercle bacilli of non-specific substances such as agar particles and trypan blue in the guinea pig than in the rabbit. (It is noteworthy that guinea pigs localize tubercle bacilli more effectively at these same sites than do rabbits.) But the greater allergic sensitivity of the reinfected guinea pig accounts for the greater release of thrombokinase from the injured cells, which is sufficient to induce the clotting process in the former but not in the latter. It is during this clotting of the exudate that, as demonstrated by Opie,[1] foreign particles and tubercle bacilli are enmeshed in the fibrin threads and removed from the lymph emanating from the site of reinfection.

There are many arguments presented for the view that antibodies are essential both in allergic sensitivity and in resistance to tuberculosis, though no unequivocal evidence is given. Yet the observed suppression of growth of tubercle bacilli in acellular agar islands penetrated by the body fluids in the immune animal as compared with their unrestricted multiplication in such positions in normal animals is attributed not to the bacteriostatic effects of immune body fluid but to the greater fibrin barrier thrown about the foci of the former. If that is true, allergy as such may be a factor in the suppression of growth of tubercle bacilli at the site of reinfection. He admits that the phagocytic capacity of some mononuclears of tuberculous animals may be greater than that of normal animals, but he feels that the bacteriotropins are more significant. That mononuclear phagocytes of immune animals may possess a greater capacity to destroy tubercle bacilli in the presence of antibody

[1] E. L. Opie, unpublished observations.

he conjectures, but the direct evidence for the greater capacity for destruction of tubercle bacilli by mononuclear cells of immune animals is not accepted on the arbitrary judgment that cultural methods are not suitable for such quantitative estimates. Yet histological evidence, in which alone Rich places full credence, leads to the same conclusion. For the same reason Rich does not accept the interpretation that mature epithelioid cells and tubercles result from the destruction of some tubercle bacilli or their products within the mononuclear cells, a concept which explains much of tuberculous lesions.

The discussion of the role of nutrition and bacillary dosage is penetrating. His distinction between "soft" and "hard" tubercles is widely accepted. Apical localization in human tuberculosis, according to Rich, indicates some increased resistance of the lung in which the upper part does not share. Rich feels that both endogenous and exogenous reinfection are responsible for adult tuberculosis. That an arrested primary infection affords some protection against reinfection is unquestioned, but the fluctuating character of acquired resistance, according to Rich, accounts for the hazard of reactivation of dormant primary or postprimary lesions.

Excellent illustrations are given of the different types of adult tuberculosis. Both tuberculous meningitis and pleural tuberculosis are considered as resulting from the extension of lesions into the arachnoid space or pleural cavity, respectively, rather than as due to hematogenous spread. The book is a "must" for all workers in tuberculosis and students of infectious disease, stimulating and absorbing reading with the added asset of an outstanding representative bibliography.

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USES AND APPLICATIONS OF CHEMICALS

Uses and Applications of Chemicals and Related Materials. Volume II. By THOMAS C. GREGORY. lxviii + 459 pp. 6 × 9¼ in. Bound in green cloth. New York: Reinhold Publishing Corporation. 1944. $9.00.

BASED on data published in the *Oil, Paint and Drug Reporter,* the first volume of this valuable compilation was issued in June, 1939, and a review of it appeared in the November 3, 1939, number of SCIENCE (p. 422). What was said there in appreciation of the many useful features of Volume I applies with even greater justice to Volume II, and the service it can render in the post-war years.

As stated in its preface, this book not only complements the subject-matter of Volume I, but also supplements it by the addition of 2,642 chemicals and related materials.

After explaining what the two volumes contain, and how the information is presented, and listing those individuals and organizations likely to find them helpful, instructions are given as to how to use the books.

Part 1 is an "Index of Uses," which records, in alphabetical sequence, the classified applications of 7,809 chemicals and related materials in the converting, compounding and processing industries. Part 2 sets forth the uses of each in a classification by industry and by application in that industry. Then follow Part 3—"Index of Synonyms and Cross References"; Part 4—"Index of Patents," and Part 5—"Index of Addresses" (*i.e.,* of owners of patents listed in Part 4).

As the reader will gather from the above, the work is encyclopedic in scope and a great mine of useful information.

ANCIENT DYES

Ancient and Medieval Dyes. By WILLIAM F. LEGGETT. Pp. iv + 95. 5 × 7¾ in. Brooklyn, N. Y.: Chemical Publishing Company, Inc. 1944. $2.25.

THIS little book, by the associate technical editor of the *Textile Colorist and Converter,* is made up of brief chapters reviewing the ancient and medieval history of the better known naturally occurring dyestuffs, and seems to cover much the same ground as his articles on "Vegetable Dyes of Ancient Usage," which have been appearing in the *Journal of the New York Botanical Garden.*

The vegetable dyes described are Madder, Indigo, Woad, Saffron, Safflower, Weld, Brazilwood, Logwood, Barwood, Camwood, the Fustics, Orseille, Cudbear, Annatto, Turmeric, Cutch, Gambir and Quercitron. Of the animal dyes, Tyrian Purple, Kermes, Cochineal and Lac are included. The few mineral compounds listed (iron salts, malachite, azurite, ochres and chalk) were much more frequently employed as pigments than as dyes.

As stated above, the treatment of the subject is historical and informative. It describes the discovery of the dyes, the origin of their names, something of the natural history of the plant or animal in which they occur, their isolation or the way in which they were applied and their commercial progress through the years. The chemistry involved is not discussed.

The book is interesting, enjoyable and instructive. It tells how the ancient peoples learned about the coloring matters present in flowers, seeds, leaves, woods, insects, sea snails, etc.

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SPECIAL ARTICLES

ISOTOPIC COMPOSITION OF PHOTOSYNTHETIC OXYGEN

RECENT interest in the isotopic composition of photosynthetic oxygen[1] has prompted us to submit for publication the results of an investigation begun in 1942, but interrupted by factors related to the war. We believe, however, that the research was carried to the point where the conclusions given here may be considered to be reliable.

Although it has been known since 1935 that atmospheric oxygen contains a greater abundance of O^{18} than the oxygen combined in water,[2] there has as yet been no convincing explanation of the phenomenon. The most attractive theory is that of Greene and Voskuyl[3] in which it is postulated that the isotopic composition of oxygen evolved in the photosynthetic reaction is an average of that in atmospheric carbon dioxide and water. As carbon dioxide which is in equilibrium with water has an enhanced O^{18} content[4] this theory could explain quantitatively the observed enrichment of O^{18} in atmospheric oxygen.

Ruben, Randall, Kamen and Hyde[5] showed by means of mass spectrometric studies of water, oxygen and carbon dioxide involved in the photosynthesis reaction that none of the oxygen atoms in the oxygen came from the carbon dioxide, but entirely from the water present. The validity of this conclusion is discussed by Kamen and Barker.[6] Assuming for the moment its correctness, the theory of Greene and Voskuyl for the greater ratio of O^{18} in air-oxygen than in water-oxygen will have to be abandoned.

However, as the experimental differences are small we decided to repeat the work of Ruben, Randall, Kamen and Hyde using the density method[7] of isotopic analysis because of the greater sensitivity of this method, and using carbon dioxide which had previously been brought into equilibrium with the water of culture medium. We found it necessary to separate the CO_2 from the reaction products as there appeared to be an oxygen isotopic exchange between the carbon dioxide and the water formed in the combination of the photosynthetic oxygen and tank hydrogen. Table 1 gives the final results of the measurements after corrections had been applied for the water used in diluting the sample to give a large enough bulk for accurate measurement and for the isotopic composition of the hydrogen used in reducing the photosynthetic oxygen to water.

As the carbon dioxide contained oxygen from which water having an excess density of 8.2 parts per million could be made, it is evident that the oxygen evolved in photosynthesis more nearly resembles the water oxygen in its isotopic composition than it does the carbon dioxide oxygen.

It is interesting to note that the excess density observed is almost exactly equal to that (1.3 parts per million) predicted by Urey and Greiff[8] for the isotopic exchange equilibrium at 25° C,

$$O_2^{16} + 2\,H_2O^{18}\,(l) \rightleftarrows O_2^{18} + 2\,H_2O^{16}\,(l) \qquad (1).$$

The data of Table 1 verify the conclusion of Ruben,

TABLE 1

EXCESS DENSITY IN PARTS PER MILLION OF WATER OBTAINED IN THE COMBINATION OF PHOTOSYNTHETIC OXYGEN

Name of plant	Extent of dilution of water sample	Excess density parts per million
Water Plants		
Chlorella Pyrenoidosa	None	0.6
Chlorella Pyrenoidosa	1.5 × original volume	1.3
Chlorella Pyrenoidosa	1.5 × original volume	1.8
Chlorella Pyrenoidosa	1.5 × original volume	1.5
Chlorella Pyrenoidosa	None	0.6
	Average	1.16
Air Plants		
Sunflower	3 × original volume	1.0
Sunflower	7 × original volume	1.1
Coleus	3 × original volume	1.4
	Average	1.17

Randall, Kamen and Hyde, while at the same time they disprove the tentative theory of Greene and Voskuyl. However, if there are other mechanisms by which oxygen atoms could exchange randomly and irreversibly between carbon dioxide and oxygen of the atmosphere, the enrichment of O^{18} in the atmosphere could then be accounted for.

This work is a contribution from the Chemical Laboratory of Northwestern University.

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[1] See the accompanying paper by M. Kamen and H. A. Barker.

[2] M. Dole, *Jour. Am. Chem. Soc.*, 57: 2731, 1935; *Jour. Chem. Phys.*, 4: 268, 1936; Swartout and Dole, *Jour. Am. Chem. Soc.*, 61: 2025, 1939.

[3] C. H. Greene and R. J. Voskuyl, *Jour. Am. Chem. Soc.*, 58: 693, 1936.

[4] L. A. Webster, M. H. Wahl and H. C. Urey, *Jour. Chem. Phys.*, 3: 129, 1935.

[5] S. Ruben, M. Randall, M. Kamen and J. L. Hyde, *Jour. Am. Chem. Soc.*, 63: 877, 1941.

[6] M. Kamen and H. A. Barker, *loc. cit.*

[7] For experimental details see M. Dole and R. L. Slobod, *Jour. Am. Chem. Soc.*, 62: 471, 1940.

[8] H. C. Urey and L. J. Greiff, *Jour. Am. Chem. Soc.*, 57: 325, 1935.

NEUROLOGICAL SIGNS IN MICE FOLLOWING INTRACEREBRAL INOCULATION OF INFLUENZA VIRUSES[1]

NEUROLOGICAL signs have been produced in mice by intracerebral inoculation of allantoic fluids containing active virus of human and porcine influenza. Injection by this route of high-titered infected allantoic fluids or concentrates of virus prepared therefrom leads in 12 to 48 hours to marked hyperirritability in up to 100 per cent. of the animals. When suspended by their tails the mice exhibit marked tremor and clonic convulsions which may change suddenly into tonic convulsions. Death occurs in a high percentage of the infected animals. Mice surviving these attacks are markedly spastic for a few minutes and refractory to repetition of these convulsions for short periods of time. In a number of animals many such attacks have been induced in the course of several days before death occurred and only a few mice survived repeated convulsions for the period of observation (10 days). Depending on the concentration of virus in the inoculum the majority of the experimental animals die within 24 to 72 hours with the described signs either spontaneously or while they are suspended. However, death in convulsions has been noted on occasion as early as 12 hours or as late as 8 days after intracerebral inoculation. Preliminary histological examinations of the brain tissue showed definite changes of meningo-encephalitic nature.

The phenomenon described was considered to be due to influenza virus for the following reasons. Four different strains of mice from unrelated and widely separated sources were used and the reaction could be elicited in each. Control injections of normal allantoic fluid, sterile broth or particulate components of normal chorio-allantoic membranes did not produce any cerebral signs. These experiments serve to exclude the activation in a latent neurotropic virus in the experimental mice.

The cerebral signs were produced under certain conditions with all strains of influenza virus tested, *i.e.*, the PR-8, WS, Weiss, F-12 and F-99 strains of influenza A, the Lee strain of influenza B obtained from two different laboratories, and a strain of swine influenza virus. The uniformity of the results tends to eliminate the possibility of contamination of influenza preparations with an extraneous virus.

The agent responsible for the cerebral signs behaves like influenza virus in every respect studied. It appears to be subject to the same optimal growth conditions in the allantoic sac of chick embryos as described for the influenza viruses[2]: Dilute inocula, which yield allantoic fluids with higher concentrations of influenza virus, produce cerebral signs more readily and in a greater percentage than allantoic fluids derived from more concentrated inocula, which usually show lower titers of influenza virus. The yield of the agent, like that of influenza virus, depends on the time of incubation in that the highest concentrations of both will be found in allantoic fluids collected 48 to 72 hours after injection of dilute inocula whereas a subsequent decrease in titer occurs on further incubation. Consequently, the mortality of mice following intracerebral inoculation may vary from 0 to 100 per cent. according to the history of the infected allantoic fluid used for injection.

The agent may be concentrated by procedures used for influenza virus, *i.e.*, by precipitation with protamine,[3] by sedimentation in the high-speed centrifuge at 20,000 r.p.m. for 20 minutes or by the method of adsorption on and elution from chick red cells.[4]

Cerebral signs may be prevented by neutralization of virus preparations with high-titered immune sera derived from various species. The agent as present in influenza A cultures is neutralized only by anti-influenza A and not by anti-influenza B or anti-swine influenza serum, while the reaction due to influenza B preparations is inhibited only by anti-B and not by the other sera, and so forth. These relationships are shown in Table 1.

TABLE 1

RESULT OF INTRACEREBRAL NEUTRALIZATION TEST

Serum	Virus preparation																				Control saline			
	Influenza A (PR-8)						Influenza B (Lee)						Swine influenza											
Anti-PR-8	0	0	0	0	0	0	D_1	C_1	D_2	D_2	C_2	C_2	D_1	C_1	C_1	C_1	C_1				0	0	0	0
Anti-WS	0	0	0	0	0	0	C_2	C_2	C_2	C_2	C_2	C_2	C_1	C_1	C_1	D_2	D_2	D_8			0	0	0	0
Anti-LEE	C_1	C_1	C_2	C_2	C_2		0	0	0	0	0	0	D_1	C_1	C_1	C_1	D_2	0			0	0	0	0
Anti-Swine influenza	C_2	C_2	C_2	C_2*	0	0	C_1	D_2	D_2	D_2	C_2	C_2	D_1	D_5	0	0	0	0			0	0	0	0
Saline	D_1	C_1	C_2	C_2	C_2	C_4*	C_2	C_2	C_2	C_2			C_1	C_2	C_2	D_5	0	0						

0 = no cerebral signs; C_1 = tonic convulsion on first day after inoculation; D_2 = died spontaneously on second day; * = clonic convulsions only.

[1] The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the Children's Hospital of Philadelphia.

[2] W. Henle and G. Henle, *Am. Jour. Med. Sci.*, 207: 705–715, 1944.

[3] L. A. Chambers and W. Henle, *Proc. Soc. Exp. Biol. and Med.*, 48: 481–483, 1941.

[4] G. K. Hirst, *Jour. Exp. Med.*, 76: 195–209, 1942; T. Francis, Jr., and T. E. Salk, SCIENCE, 96: 499–500, 1942.

The phenomenon has been observed, thus far, only with active influenza virus preparations. Inactivation by ultraviolet irradiation, heat or formalin rendered the preparations innocuous. On the other hand, irradiated preparations have given evidence of interference in accord with experience gained with the influenza viruses.[5] When high concentrations of irradiated virus were injected simultaneously with active homologous or heterologous virus by the intracerebral route reduction in the incidence of convulsions was noted as compared to the controls inoculated with active virus alone.

Although only active virus has been found to elicit the phenomenon, no propagation of the influenza virus in the brain tissue could be demonstrated. When brains were harvested from mice immediately after intracerebral inoculation of PR-8 or Lee virus, or 24, 48 and 72 hours later when cerebral signs were apparent, titration of emulsions of these brains in eggs revealed that the amount of influenza virus did not increase in the brain but rather decreased to less than 0.1 per cent. of the amount of virus found in the brain immediately after inoculation. Furthermore, attempts to pass the agents from mouse brain to mouse brain at three day intervals failed in several trials. No neurological signs were noted in the second brain passage and subcultures in eggs from the third cerebral passage failed to demonstrate the presence of influenza virus.

The phenomenon described can be elicited not only by influenza viruses grown in the allantoic cavity of the developing chick, but also by strains which have been maintained continuously by mouse lung passage. Potent suspensions of infected mouse lungs and concentrates therefrom behave essentially similar to infected allantoic fluids.

Neurological signs of similar nature caused by influenza virus have been reported previously by Stuart-Harris[6] and Francis and Moore,[7] who were able to adapt certain strains to mouse brain passage. The results of these authors differ from ours in various respects: Infected chick brain tissue cultures or mouse lungs served as starting material; the virus multiplied in the brain tissue; neurological signs developed only after from 3 to 12 cerebral passages; the incubation period varied from 3 to 11 days; and only two strains (WS and Melbourne) could be established in this way, while the PR-8 strain gave negative results. In contrast to these observations we used mainly allantoic fluid preparations of influenza virus which caused the indicated signs on first passage to the mouse brain, usually within 24 to 72 hours and in exceptional cases only as late as 6 to 8 days after inoculation; the agent could not be passed from brain to brain in series, and finally, all strains of influenza virus tested gave the result, provided enough virus was present.

These apparent differences may possibly be explained by the assumption that influenza virus in sufficient concentration is toxic for the brain tissue without showing propagation in the CNS. As shown by the other workers,[6,7] only a few strains are able to multiply in the brain tissue, in which case enough virus accumulates gradually to elicit the toxic reaction. This would imply a separation of the propagating property from the toxic activity. In this regard it is of interest to note that toxic properties of another group of viruses have been observed recently by Rake and Jones.[8]

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[5] W. Henle and G. Henle, SCIENCE, 98: 87–89, 1943; *Am. Jour. Med. Sci.*, 207: 717–733, 1944. J. E. Ziegler, G. I. Lavin and F. L. Horsfall, Jr., *Jour. Exp. Med.*, 79: 379–399, 1944.

[6] C. H. Stuart-Harris, *Lancet*, 1: 497–499, 1939.

[7] T. Francis, Jr. and A. E. Moore, *Jour. Exp. Med.*, 77: 717–728, 1940.

[8] G. Rake and H. P. Jones, *Jour. Exp. Med.*, 79: 463–486, 1944.

THE INHIBITING EFFECT OF SODIUM AZIDE ON MOLD GROWTH[1]

THE growth of molds on a variety of materials is of great economic and military significance. In addition to this well-known activity, infections of man and animals, particularly of the skin, are matters of considerable importance. In view of these facts, the chance observation that high dilutions of sodium azide (NaN_3) prevented the growth of *Penicillium notatum* seemed worthy of further investigation. The inhibiting action of sodium azide on biological processes was first described by Keilin and Hartree[2] in respect to catalase. Snyder and Lichstein[3] suggested the addition of this chemical to bacteriological media employed for the isolation of gram-positive organisms from specimens of urine and feces containing a preponderance of gram-negative bacteria since its selective inhibition for the gram-negative coliform bacteria had been demonstrated by Bryan, Devereux, Hirschey and Corbett.[4]

In determining the concentration of NaN_3 which would inhibit the mold growth, modified Chapek-Dox media[5] containing varying concentrations of NaN_3

[1] From the Hygienic Laboratory, University of Michigan, Ann Arbor.

[2] D. Keilin and E. F. Hartree, *Nature*, 134–933, 1934.

[3] M. L. Snyder and H. C. Lichstein, *Jour. Inf. Dis.*, 67: 113, 1940.

[4] C. S. Bryan, E. D. Devereux, W. C. Hirschey and A. C. Corbett, *North. Am. Vet.*, 20: 41, 1939.

[5] W. Kochalaty, *Jour. Bact.*, 44: 469, 1942. Constituents: $NaNO_3$ 2.0 g, KH_2PO_4 1.0 g, KCl 1.0 g, $MgSO_4$ 0.5 g,

were inoculated with 12 different molds. Following an incubation period of 15 days, none of the 12 strains showed indications of growth in the presence of 0.01 per cent. NaN_3, while 0.001 per cent. partially inhibited the growth of all the molds.[6] When 1½ per cent. of agar was added for the purpose of obtaining surface cultures 0.001 per cent. retarded growth, but it was necessary to increase to 0.01 per cent. in order to inhibit completely *Penicillium glaucum, Aspergillus niger, Mucor rhizopodiformis* and *Oidium albicans.*

In view of the aforementioned observations it seemed desirable to investigate the possibilities of using NaN_3 as a chemotherapeutic substance. To do this it would be most desirable to obtain infections in animals similar to the naturally occurring infections, and evaluate the changes produced following the applications of the chemical. Unfortunately, it is most difficult to produce such infections in animals, therefore attention was directed to its toxicity following intraperitoneal injections. There are references in the literature to the action of NaN_3 on animals and the consensus of opinion seems to indicate an action similar to that of the cyanides on living tissue. Physiological saline solution (PSS), in 0.3 ml quantities containing 0.30 mg NaN_3, on intraperitoneal injection into 20-gram mice was capable of producing convulsions and death in less than 20 minutes, while a single dose of 0.10 mg in 0.10 ml of PSS elicited no neurological signs. Accordingly, 0.10 ml of a solution containing 0.10 mg was administered by the same route every 2 hours for a period of 28 hours, 5 of 7 animals died during the experiment. Blood taken 10 minutes after intraperitoneal administration of 0.10 mg of NaN_3, placed in a test-tube and inoculated with *Penicillium notatum* did not contain enough of the chemical to inhibit growth. On this basis it seems that NaN_3 holds little promise for the treatment of systemic infections.

Fungicidal tests are now in progress.

J. EMERSON KEMPF
WALTER J. NUNGESTER

PENICILLIN IN OIL SUSPENSION. BACTERIOSTATIC AND SPIROCHETICIDAL AGENT[1, 2]

PENICILLIN, dissolved in water or in a glucose solution, has been used intravenously by the continuous drip method or by intramuscular injection every four hours. The purpose of the continuous administration is to maintain the necessary blood stream concentration which is constantly diminished because of the rapid elimination of penicillin. The intravenous drip method as well as frequent intramuscular injections are troublesome to the patient and necessitate the attendance of physicians or nurses and therefore hospitalization. All this implies great expense; indeed, in the case of syphilis and gonorrhea the cost of treatment becomes prohibitive. Thus the problem of reducing the speed of elimination of penicillin from the body is seen to be urgent. When back in 1938 we experimented with sulfanilamide suspensions in oil which was intramuscularly administered to mice, we were impressed with the excellent therapeutic results obtained by this method.

In experimenting with penicillin sodium, our first step was to suspend a finely pulverized sample in some dry sterile vegetable oil, such as peanut oil. It is well known that penicillin sodium dissolved in water is unstable even if kept in the refrigerator, the potency being completely lost in the course of a few days. But when we suspended penicillin in oil, we found to our great surprise that it remained stable for more than two months, as evidenced by the undiminished bacteriostatic effect. In a continuation of the experiment with this sample, there appears the possibility of its remaining intact for a very much longer period, if kept in a refrigerator. Our bacteriostatic tests, which disclosed the above-mentioned facts, were done according to the agar cup-plate method.[3] These tests indicated that 24 hours after the preparation of penicillin sodium in oil suspension, it had a bacteriostatic effect measured by clear zone around the cup of 12 mm. After 8 weeks the bacteriostatic effect was practically the same, namely, 11.5 to 12 mm.[4]

The extraordinary stability of penicillin when suspended in oil led us to the assumption that its effect in this form may be somewhat greater therapeutically than penicillin in aqueous solution, because it is less liable to destruction in the animal body and capable of more gradual absorption. All this was confirmed by our animal experiments. The blood of rabbits which

$MnSO_4$ 10 mg, glucose 40.0 g, and distilled water to 1,000 ml.

[6] *Mucor rhizopodiformis, Aspergillus niger, Aspergillus flavus, Oidium albicans, Hormodendrum compactum, Histoplasma capsulatum, Blastomyces dermatitidis, Trichophyton gypsium, Trichophyton floccosum, Penicillium notatum, P. glaucum* and *P. citrinum.*

[1] From the Dermatological Research Laboratories, Philadelphia, Division of Abbott Laboratories, North Chicago, Illinois.

[2] The author wishes to thank Drs. J. H. Stokes, H. Beerman and J. W. Lentz for their valuable advice and help in carrying out this research. The author wishes also to acknowledge with deep appreciation the assistance of Dr. M. Severac and J. C. Moetsch in the experimental work.

[3] "U. S. Food and Drug Administration Methods of Testing Antiseptics and Disinfectants," Circular No. 198, December, 1931, U. S. Department of Agriculture.

[4] C. Nielsen, of the Abbott Laboratories, North Chicago, Illinois, in a personal communication reported that suspensions of penicillin in peanut oil were found to be stable even at incubator temperature, that is, at 37° C. In his experiments the original bacteriostatic values remained the same after incubation for 30 days.

were given intramuscular injections of penicillin oil suspensions remained bacteriostatic for a longer period of time than when penicillin was administered in aqueous solution. In these experiments all the rabbits received intramuscularly 4,000 Oxford units of penicillin per kilo. When the penicillin was administered in aqueous solution, the blood became bacteriostatic for only one hour.[5] This was evidenced by the absence of growth of *Staphylococcus aureus* in broth culture mixed with rabbit blood. But bloods obtained one and one half, two, three, four and five hours later did show growth. On the other hand, when the blood of other rabbits which received penicillin in oil suspension was tested, the results proved that it was bacteriostatic one, one and a half and two hours after intramuscular injection, as determined by the absence of growth. Three, four, five and six hours afterwards, growth was observed—thus indicating the cessation of bacteriostatic effect.

The next experiment involved the treatment of rabbit syphilis by intramuscular injections of penicillin sodium suspended in oil. Rabbits were infected intratesticularly with a suspension of *Spirocheta pallida*, according to the method previously described by us.[6] One syphilitic rabbit was given intramuscularly 2,500 Oxford units per kilo body weight of penicillin sodium in aqueous solution twice a day consecutively for 8 days, totaling 40,000 units. The testicles were not free of spirochetes until the 14th day, and the complete healing of the lesions occurred at the end of 42 days. Two other rabbits were each administered intramuscularly 5,000 Oxford units per kilo of penicillin in oil. In this case, however, each animal was given penicillin only once a day for a period of 8 days, comprising again a total of 40,000 units. In both rabbits, the testicular lesions became negative for spirochetes in less than 10 days and the testicles appeared normal at the end of 35 days.

From the above it may be concluded in a preliminary way that penicillin in oil suspension is therapeutically somewhat more active in experimental rabbit syphilis than penicillin in aqueous solution. The superiority of the oil suspension, however, lies chiefly in the fact that the administration of the drug can be reduced to only one treatment a day. This experimental study opens the way to a method by which syphilis patients can be treated with penicillin in oil by a greatly simplified procedure. One daily intramuscular injection may thus suffice. This study further suggests a possibility of replacing the intravenous drip method and similar procedures by a few intramuscular injections of penicillin in oil to be used in the treatment also of various bacterial infections.

GEORGE W. RAIZISS

[5] Rabbit's blood was diluted with broth culture in the proportion of 1 to 20. This culture was seeded with a resistant strain of *Staphylococcus aureus* using one 4 mm loop of a 1–1,000 dilution.

[6] George W. Raiziss, *et al.*, *Am. Jour. Syph. and Neurol.*, 19: 473, October, 1935.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR THE COLORIMETRIC DETERMINATION OF PHOSPHORUS[1]

IN 1920 Bell and Doisy[2] devised a method for the colorimetric determination of phosphorus. This consisted in adding sulfuric and molybdic acids to the unknown ortho phosphate solution and reducing the phosphomolybdic acid thus formed by means of hydroquinone in a carbonate-sulfite medium. The resulting blue solution was read in a colorimeter against a standard. Briggs[3] improved the method by changing the order of adding the reagents. Fiske and Subbarow[4] considerably improved the method by substituting aminonapthol sulfonic acid for hydroquinone. Since the reduction of phosphomolybdic acid by aminonapthol sulfonic acid proceeds relatively slowly at room temperature, Lohmann and Jendrassick[5] have advocated heating the reactants to 37° C. for from 5 to 7 minutes. Allen[6] has employed amidol (2,4 diaminophenol dihydrochloride) in place of aminonapthol sulfonic acid, since this is a very powerful reducing agent. Kuttner *et al.*[7, 8] have used stannous chloride as the reducing agent, and this compound has been employed successfully by Youngburg and Youngburg.[9] Bodansky[10] found that trichloracetic acid caused deviations from Beer's law when the stannous chloride procedure was employed. He published a table of corrections.

While the Allen method has a number of minor dis-

[1] From the Biochemistry Laboratory, Cornell University, Ithaca, N. Y.

[2] R. D. Bell and E. A. Doisy, *Jour. Biol. Chem.*, 44: 55, 1920.

[3] A. P. Briggs, *Jour. Biol. Chem.*, 53: 13, 1922; 59: 255, 1924.

[4] C. H. Fiske and Y. Subbarow, *Jour. Biol. Chem.*, 66: 375, 1925.

[5] K. Lohmann and L. Jendrassick, *Biochem. Zeits.*, 178: 419, 1926.

[6] R. J. L. Allen, *Biochem. Jour.*, 34: 858, 1940.

[7] T. Kuttner and H. R. Cohen, *Jour. Biol. Chem.*, 75: 517, 1927.

[8] T. Kuttner and L. Lichtenstein, *Jour. Biol. Chem.*, 86: 671, 1930.

[9] G. E. Youngburg and M. V. Youngburg, *Jour. Lab. Clin. Med.*, 16: 158, 1930.

[10] A. Bodansky, *Jour. Biol. Chem.*, 99: 197, 1932.

advantages, in my opinion it is to be preferred to all other methods, if one is estimating inorganic phosphate in the presence of some easily hydrolysable phosphorus compound, such as glucose-I-phosphate. When, however, there is no likelihood of decomposing some such labile phosphorus compound I have found it preferable to employ reduction by stannous chloride, as in the method of Kuttner *et al.*, or Youngburg and Youngburg. The chief disadvantage of stannous chloride is that it will give a blue reduction compound with molybdic acid itself unless a relatively high concentration of sulfuric acid is first added, and this high concentration of sulfuric acid causes a rather rapid hydrolysis of such esters as glucose-I-phosphate, thus making determination of the preformed phosphate impossible.

I have found ferrous sulfate to be a more satisfactory reducing agent than either amidol or stannous chloride, all things considered. When added in slight excess it reduces phosphomolybdic acid to the end-point within a few seconds. The blue color thus produced has been found to increase in intensity by about 2 per cent. after standing for 2 hours. Change in room temperature from 18 to 25° C. is practically without effect. As much as 10 cc of 10 per cent. trichloracetic acid does not interfere with the test. With ferrous sulfate, as with stannous chloride, it is necessary to add sulfuric acid in order to prevent color production through a reduction of the molybdic acid. But with ferrous sulfate the quantity of sulfuric acid that must be added is so much less that a rapid hydrolysis of labile esters of phosphoric acid does not occur. Solutions of ferrous sulfate have a slight color, but this can be ruled out by using a solution containing only the reagents to set the photoelectric colorimeter at the null point. This blank solution remains usable for several hours.

The only drawback with ferrous sulfate is that its solutions undergo spontaneous oxidation. I have found it necessary to make up new solutions every 2 hours. This may sound disadvantageous; actually it is not, since only a few seconds are needed to weigh out granular ferrous sulfate roughly, add water from a graduated cylinder, add sulfuric acid and mix.

The Method

Pipette into a 24×200 mm tube, graduated at 50 cc, a known volume of the orthophosphate solution which is to be analyzed. The amount of phosphorus present should lie between 0.01 and 2.2 mg. Add 5 cc of 6.6 per cent. ammonium molybdate, $(MH_4)_6Mo_7O_{24} \cdot 4H_2O$, and distilled water to about 40 cc. Add 5 cc of 7.5 N sulfuric acid and mix gently by rotating the tube. Now add 4 cc of the ferrous sulfate (5 gm $FeSO_4 \cdot 7H_2O$ in 50 cc of water and 1 cc of 7.5 N H_2SO_4). Dilute to the 50 cc mark, stopper with a clean rubber stopper and invert the tube 4 or 5 times. Prepare a blank in a second tube, using the same amount of molybdate sulfuric acid and ferrous sulfate. Now employ the blank solution to set the photoelectric colorimeter at the null point using the red glass filter. Next read the unknown. The mg of phosphorus present are obtained from a graph. This is prepared by running determinations of various quantities of a standard solution of pure KH_2PO_4 and plotting the scale A readings against mg of phosphorus. This will give a perfectly straight line. Table 1 gives some values which I have employed to construct a graph for our Fisher photoelectric colorimeter. These values will not apply to other instruments.

TABLE 1

Mg. phosphorus	Scale A reading
0.0263	10.7
0.0527	21.6
0.105	42.5
0.158	64
0.211	84

Summary

A method is described for the colorimetric determination of phosphorus, using ferrous sulfate as a reducing agent.

I wish to express my gratitude to the Rockefeller Foundation for financial assistance.

James B. Sumner

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SCIENCE NEWS

Science Service, Washington, D. C.

DISCOVERY OF TWO FAINT NEBULAE

DISCOVERY of two new members of our local group of galaxies, vast number of stars whirling through space together, may bring us closer to solving the riddle of how our world came into existence. This brings to thirteen the number of galaxies, close neighbors to our own galaxy or Milky Way, with which we are familiar.

The two faint nebulae, representing previously unobserved stages through which a stellar system passes in changing from a nebula which is either round or elongated in shape into a globular group of stars, are reported by Dr. Walter Baade, of the Mount Wilson Observatory, of the Carnegie Institution, at Pasadena, Calif., in the current number of the *Astrophysical Journal*. Known to astronomers by the New General Catalogue numbers of 147 and 185, the nebulae in structure differ considerably from typical elliptical nebulae which become continually brighter toward the center and gradually get fainter toward the edge.

The pair, Dr. Baade reports, seem to be intermediate in form between systems like NGC 205, in which it is just apparent that the usual distribution of stars in elliptical nebulae is no longer being followed, and the Sculptor and Fornax systems, globular systems where so few stars seem to be grouped together that observers hesitate to claim that they belong to the group of elliptical nebulae.

"It seems that a marked change in the internal structure of the elliptical-type nebulae takes place as we reach the systems of lowest luminosity," Dr. Baade states. The strong concentration of stars toward the center and the central nucleus gradually disappear. In one nebula investigated the central nucleus was faint, in the other it was entirely missing.

For years elliptical nebulae have puzzled astronomers anxious to investigate the secret of their creation. It seemed impossible, even by the most powerful instruments, to photograph the individual stars. It has recently been discovered, however, that when red-sensitive plates were substituted for the blue used hitherto, stars just beyond the reach of the blue-sensitive plates could be photographed.

By means of red-sensitive plates nebulae can now be resolved with the 100-inch telescope if their distance is not greater than 300,000 parsecs or about 980,000 light years. Since this distance coincides with the distance adopted for the outer limit of the local group of galaxies, ability to resolve the nebula into stars provides a convenient criterion by which nebluae within the "family circle" can be distinguished from those outside.

The pair of elliptical nebulae chosen by Dr. Baade are about the same distance from us as the great Andromeda spiral, now visible high in the evening sky, near which they are located. Both systems were easily resolved into stars on the red-sensitive plates, the brightest stars in the groups appearing to be about as brilliant as those in Messier 32, NGC 205 and the inner part of the Andromeda nebula, recently investigated by Dr. Baade.

Showing only an ill-defined elongated patch of faint nebulosity by ordinary plates, under red exposure NGC 147 appears as a large star cloud. Although its shape could only be guessed at before, it now seems to be definitely ellipsoidal in structure. Its absolute magnitude is about the faintest thus far observed in a galaxy, but it is clearly visible because of its nearness to us. Long known to have two dark clouds near the center, on red-sensitive plates the individual stars of NGC 185 can easily be distinguished. Considerably brighter than its companion, the nebula may well be described as a slightly elongated, giant globular cluster of stars.

ITEMS

CONTINUING its "good neighbor" policy of stimulating interest in aviation in neighboring American republics, the Civil Aeronautics Administration, in cooperation with the State Department, recently announced that applications are now being received for 128 aviation training scholarships in 19 Latin American countries under the CAA's fourth Inter-American training program. These scholarships, financed by the State Department, entitle successful candidates to one year of training in the United States at CAA selected schools. Provision has been made under the present program to train 19 pilots, 37 mechanics, 35 communications technicians and traffic control workers, and 37 others who will receive on-the-job training in other aviation activities. Examinations will be given on December 1 and selection of successful candidates will be made by committees in each of the 19 countries. Training will begin in the United States about two months later.

To improve the quality of aerial photos and to make it easier for photo-reconnaissance experts to put together the hundreds of pictures that make up photo montages used by field commanders in planning military operations, a new device times the taking of photos to provide a uniform percentage of overlap in all photos. Known as the intervalometer, it is designed to click the shutter automatically in one or more aerial cameras at predetermined intervals with a range of from 1 to 120 seconds. Developed by the Fairchild Camera and Instrument Corporation, the controls of the new device are installed on the instrument panel of the plane. Cameras which may be back in the tail of the plane can be operated by this remote control system. As many as seven fully automatic aerial cameras are operated in synchronization by one controlling device. In addition, there is an extra-picture switch button, permitting the aerial photographer to take an extra picture if he happens on an unusual subject that does not fall within the interval timing, without interrupting the predetermined scale. A thermostat-controlled electric heater keeps the equipment at uniform temperatures during high altitude flight. The resulting overlap provides the same area coverage in any given strip of pictures. This results in a uniform percentage of overlap in all photos taken from an identical altitude but to different scales.

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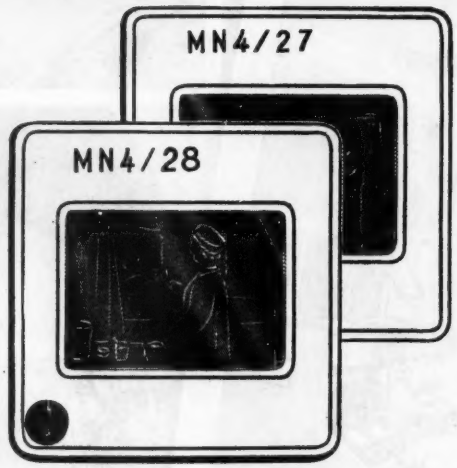

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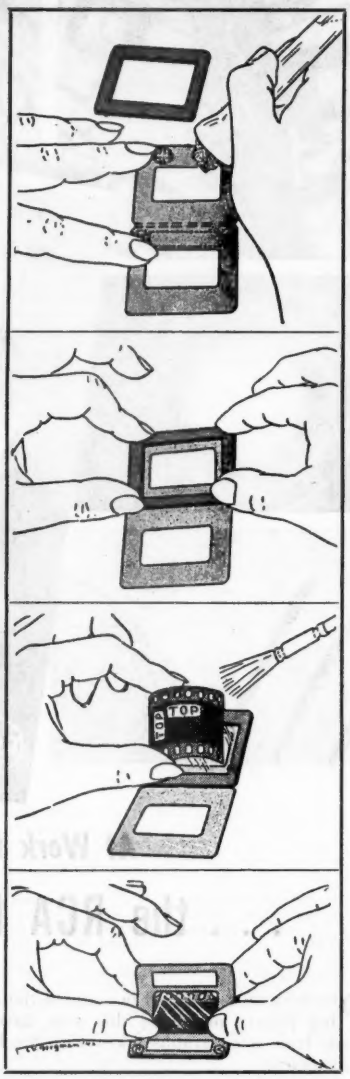

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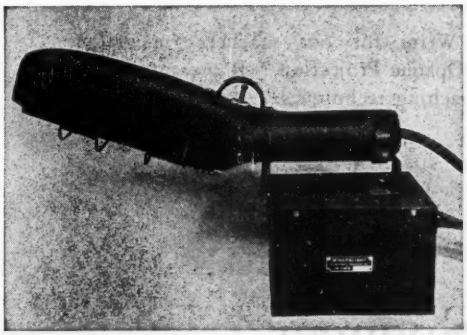

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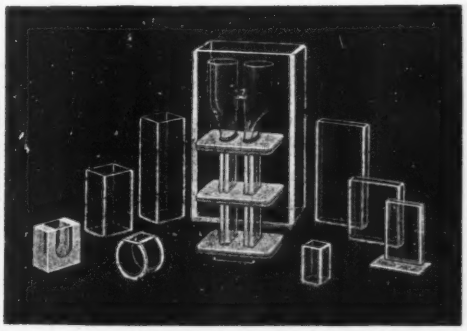

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